In reply, Mr. Duncan urged that the work had been done in a careful manner; secondly, that the wall had been in a ruinous and dangerous condition for a considerable time previous to the commencement of the underpinning; thirdly, that no injury, beyond such as could not be avoided by the exercise of any amount of skill, was occasioned by the underpinning; and, fourthly, that the said wall ought not to be rebuilt, inasmuch as Mr. Andrew's house has been condemned to be pulled down, and that any expense attending the pulling down or rebuilding of the said wall ought to be borne by the owner of the house; and that any injury to the premises, or inconvenience, would be amply compensated for by the payment of a sum not exceeding 10*l.*, regard being had to the large sum already expended in underpinning the wall, and to the circumstance that he waved any claim to any portion of the materials of such wall.

The referees awarded,—that Duncan had cut away and underpinned contrary to the Act, and for want of care had caused the ruinous condition of the wall; that the wall had been previously defective, but that, not having availed himself of the proceedings directed by the Act, he was not relieved from his liability; and they called upon him, at his own cost and charges, forthwith to pull down and rebuild the wall.

Expenses of office (5*l.* 13*s.* 11*d.*), and 2*l.* 2*s.* to district surveyor, to be paid by Duncan.

THE MANUFACTURE OF IRON IN SOUTH WALES.*

The iron trade of South Wales very much surpasses in magnitude that of any other district of the United Kingdom. From the mineral district of Monmouth and Glamorgan alone a supply of some four hundred thousand tons is annually conveyed to the sea. The whole district has been estimated to include an area of about 1,000 square miles. The Glamorganshire ore is almost entirely argillaceous, in balls or nodules, or in bands or strata, both enveloped in beds of indurated clay shale, or 'bind.' The Welsh ore contains about 33 per cent. of metal, and is probably about 3 per cent. richer than that of Staffordshire.

The materials employed in the reduction of iron are principally three. Firstly, the *iron-stone*; secondly, the *fuel*; and thirdly, the *flux*. The iron-stone, technically called 'mine,' is found in numerous thin bands dispersed among the coal measures. With it a considerable quantity of the slate clay or 'bind' is brought to the surface. Here it forms round the mouths of the working heaps termed 'spoil banks,' which disfigure the iron country. The 'mine' is carefully stacked, and after some months the 'bind' scales off, and a tribe of women and children, hammer in hand, complete this process. It is then roasted with coke in a kiln, and its weight reduced 20 to 40 per cent., when it is ready for the blast furnace.

Since the ore is a metallic oxide, it is necessary to expose it to some influence that will remove the oxygen, and thus liberate the metal. This is effected by the use of a fuel as near to pure carbon as is practicable. Formerly, in England, as now in Sweden, charcoal was the fuel employed, and it is still considered to be superior to any other. Small quantities of charcoal iron are indeed still prepared at Backbarrow and elsewhere in Westmoreland, for the manufacture of wire and other fabrics requiring great ductility; but much of the Backbarrow iron of commerce is innocent of any connection with the place whence it derives its name. Most of the iron of this country, which has been manufactured above a century, is charcoal iron, and the area bars and railings of the older parts of London are well known to and sought after by the dealers in old iron.

The importance of the subject of fuel to an iron-work may be conceived from the following statement:—Taking the annual domestic consumption of coal in Great Britain at 38,500,000 tons, and that consumed in the manufacture of pig and bar iron at an average of about 6 tons to the ton of metal, the consumption in this manufacture will be 6,750,000, or towards 9,000,000 of tons per annum, or nearly one quarter of the whole consumption. The consumption round Merthyr, for the year 1839, was nearly equal to that of an ordinary city of 1,450,000 inhabitants.

The flux combines with the earthy matter of the ore, as the fuel with its oxygen. The calcareous ores of Forest of Dean require an argillaceous flux, the argillaceous ores of Glamorgan a calcareous. In either case the lime and clay enter into combination, and leave the metal free.

The blast furnace, in which all the ingredients are to be combined, constitutes the prominent feature of the establishment. In Wales it is a gigantic kiln, in form of a truncated pyramid, measuring at base 30 to 50 feet each way, and at summit 25 to 30. It stands about 45 or 50 feet high, and within its top is placed a large cylindrical chimney, or tunnel head, rising about 12 feet more. Each face contains a large arched recess, gradually diminishing towards the centre of the structure, and intended for the entrance of the blast and the removal of the melted metal. The effect of a range of these huge black furnace towers looming through the smoke, and capped each by its flickering pyramid of flame, is very imposing. They confer upon the rest of the works that sort of character that castles, such as those of Dover, London, or Richmond, derive from their Norman keeps. The interior of the furnace is a double cone, in shape very much resembling an old fashioned decanter placed upon a funnel. The materials are put in at the top, and the products collected and removed by means of the pit at the bottom.

Where practicable, a blast-furnace is commonly built against the side of a hill, scarped down for that purpose, and the minerals are all arranged upon a platform at the summit, requiring only to be loaded, measured, and wheeled in. Below, in front of the furnace, are the cast-house, refinery, and other buildings intended for the immediate reception of the metal. Speaking generally, a charge is composed of about 6 cwt. of coke, the same quantity of mine, and rather above a third of that quantity of limestone. The furnace receives about fifty such charges in a 'turn' of twelve hours.

To carry forward so rapid a combustion a copious blast must be forced into the furnace. To effect this, a steam-engine pumps air into an iron globe or reservoir, 18 to 25 feet in diameter. Here the air, condensed under a pressure of about 2½ pounds on the square inch, exerts an expansive force, and is led away in tubes to the several furnaces, which are thus blown with a blast of uniform and known force. The blast-pipes are kept cool by introducing them through a double funnel or 'tuyere,' filled with water. Of such great consequence is the regularity of the blast, that upon its stoppage for any length of time, the contents of a furnace have been known to become solid. Under such circumstances the steam-engine is a most valuable auxiliary. It was first applied to the blast-furnace in 1770, and the 'make' of iron was speedily doubled.

A blowing engine has been calculated to pour into its receiver about 137 cubic feet of air per horse power per minute, so that, allowing 30-horse power to each furnace, we shall have a supply per minute of about 4,000 cubic feet. From this let one-eighth be deducted for waste and the service of the 'finery,' and 3,500 cubic feet will remain to pass into each blast furnace, being at the rate per turn of twelve hours of 2¼ millions of cubic feet, or about 88 to 90 tons weight of air.

A blast-furnace should never be suffered to go out. The supply at the top should be perpetual, and the tapping at the bottom be performed at regular intervals. In this way furnaces will remain in blast for many years. At Dowlais, the largest iron-work in the kingdom, it was found, however, that the blast might be stopped on Sundays for eight hours, and this has since, in these works, been regularly practised. This necessity for keeping the blast-furnaces in general action causes a serious financial difficulty in the trade, since the iron master cannot readily reduce his 'make' to meet his orders.

In some works the supply of water is sufficiently copious to admit of its general use as a power in the place of steam. This is the case to a certain extent about Merthyr, where the Cyfarthfa water-wheels have long been celebrated for their size and excellent construction. The cost of a Welsh blast-furnace complete, with its share of the blast-engine and appendages, is estimated at about 6,500*l.*

The general theory of the changes effected in the blast-furnace is simple. In the upper part of the furnace the heat is sufficiently great to drive off any volatile substances that may have escaped the kiln or the coke-field, so that the materials reach the centre free from any extraneous matter, at a high temperature, and ready to form new combinations. The carbon of the fuel unites with the oxygen of the ore, and passes off as carbonic oxide gas. The limestone, reduced to its quick or caustic state, combines with the argillaceous part of the iron-stone to form a dense semi-vitreous slag or cinder. The metal, thus set free, melts and descends to the bottom of the furnace, to be from time to time let off. The slag rests upon the fluid metal and preserves it from the wasting action of the blast. The excess of slag flows over through a proper opening, and by its condition the workman judges of what is going forward within.

Furnaces generally work better in winter than in summer. Under favourable circumstances, the weekly 'make' or 'yield' of a Welsh furnace is from 60 to 100, or even 120 tons.

The furnaces are tapped twice in the twenty-four hours, when six tons is considered to be a good yield. The evening casting is a most beautiful spectacle. The furnace keeper, standing in the deep shade of the arch, breaks up, by the aid of a long bar, the clay with which the orifice is stopped, the blast is for a moment cut off, the full depth of the arch becomes lighted up, and the metal, foaming and sparkling with a light not endurable by the unpractised eye, gushes forth in a single stream.

The flow of the metal in the main trench or 'sow' is so regulated, that each of the side trenches or 'pigs' shall receive a full trough, or about one hundred weight of metal. Whilst this is going forward the furnace shoots up a vast volume of flame, accompanied by a brilliant shower of sparks, so that the act of casting is proclaimed for many miles around. When the iron has been run out, the "sow and pigs" are covered up with sand to cool, and the works are restored to comparative tranquillity for the next twelve hours.

The loss by this process is estimated at about 40 per cent., being 60 to 70 per cent. upon this and the preceding operations, so that three tons of raw 'mine' may be taken as producing one ton of pig iron.

Carbon seems to bestow a certain degree of softness, toughness, and fusibility upon the metal, and, therefore, pig iron moderately carbonised is more valuable for conversion into bar-iron than the metal in a purer state.

Castings direct from the blast-furnace are of an inferior description. The quality of the metal is uncertain, and the arrangements of the place and the habits of the people are unfavourable for delicate operations. Heavy castings, however, as fly-wheels and shafts, and the ordinary castings for the use of the works, are always 'run' on the spot, and commonly direct from the blast-furnace. Pig-iron, as an article of export, is purchased by founders and machinists, who, by melting down pigs of different qualities in their smaller furnaces, are able to produce a homogeneous metal of almost any quality, and of equable powers of contraction throughout the mass. The principal quantity, however, of Welsh pig-iron is converted on the spot into malleable-iron by a series of processes, of which refining is the first.

The *refinery* is a broad shallow hearth, closed permanently at the two sides, open in front, and capable of being closed behind by means of a pair of iron folding doors. Above is a low chimney. In this furnace a proper charge of coke and pig-iron is placed. Two blasts, one on each side, are set in action, and a strong heat is kept up for two or three hours. The fused metal falls upon the hearth, and there receives the full force of the blast under circumstances highly favourable to the combination of its oxygen with the carbon of the metal. The refinery is fed from time to time with coke (or coal), but the supply of iron is given only at the commencement of the process.

As the iron fuses, the refuse or cinder is

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